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DISTRIBUTION, SCUTELLATION, AND REPRODUCTION IN THE QUEEN SNAKE, *REGINA SEPTEMVITTATA* (SERPENTES: COLUBRIDAE), FROM ARKANSAS

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ABSTRACT

The queen snake, *Regina septemvittata*, has a disjunct portion of its distribution in Arkansas. This rare, crayfish-eating species is best known from only a few isolated populations from several major streams that flow out of the Boston Mountains of the Ozark Plateau. A field study of this species was conducted during the summer of 1990, and only 4 specimens were documented. Gravid females were collected in July; sperm production was also noted in July. Parturition presumably takes place in August or early September. This species may qualify as threatened or endangered in Arkansas.

INTRODUCTION

The queen snake, *Regina septemvittata*, is a medium-sized, semi-aquatic, crayfish-eating, natricine snake and has an extensive distribution in the eastern United States and a much smaller disjunct distribution in the Interior Highlands of Arkansas and Missouri (Conant, 1975). The trans-Mississippi River populations are disjunct from the westernmost extent of the main body of the species' range by over 400 km. The queen snake is best known in Arkansas from only a few isolated populations from several major streams that flow out of the Boston Mountains of the Ozark Plateau. Although the Mulberry River of west-central Arkansas (Franklin and Johnson counties) historically contains documented scattered populations (Dowling, 1957; Conant, 1960; Weatherby, 1974; Trauth, 1988), many other streams have not been investigated as thoroughly as this one. The first specimens of *R. septemvittata* collected in Arkansas were taken from the Hot Springs area (Garland County) between 1894 and 1896 (Hurter and Strecker, 1909). After conducting an exhaustive search for voucher specimens, Conant (1960) could find records for only seven specimens from Arkansas and three from Missouri. Recently, Johnson (1987) mentioned that no additional specimens of queen snakes have been reported from Missouri since 1927. Plummer (1980) reported two significant new county records for Arkansas; these localities (Cadron Creek – Faulkner County; Salado Creek – Independence County) represent populations that reside outside of the published range (Conant, 1975).

Dowling (1956) discussed a possible correlation between the presence of endemic relictual populations of amphibians and reptiles in the Interior Highlands of Arkansas and the geologic and paleoclimatic history of the region. Surprisingly, Dowling (1956) failed to include *R. septemvittata* as occurring in either the Arkansas River Valley or the Ouachita Mountains. He suggested that the disjunct distributions present in many of the species' ranges occurred following herpetofaunal immigrations into this region during four separate climatic episodes during the late Pleistocene or early Holocene (Smith, 1957; Auffenberg and Milstead, 1965; Cole, 1971). A striking parallelism exists between the two disjunct segment of the range of *R. septemvittata* and its principal food source, crayfish of the genus *Cambarus*, in Arkansas (Conant, 1960; Branson and Baker, 1974).

Literature dealing with the natural history of the queen snake is scant; the only intensive ecological study was conducted by Branson and Baker (1974) in Kentucky. Recent studies on *R. septemvittata* include the topics of skin permeability (Stokes and Dunson, 1982), scale surface microstructure (Price, 1983), flight responses (Layne and Ford, 1984), foraging habits (Godley *et al.*, 1984), and coccidian parasites (Upton *et al.*, 1991). Weatherby (1974) conducted a study on the population genetics of *R. septemvittata* throughout its range and utilized 21 specimens (mostly neonates) from Johnson County; other than checklists (Vance, 1985), general accounts in books (Mount, 1975; Ernst and Barbour, 1989), and Conant's review (1960), Weatherby's work represents the only major document on any aspect of the biology of the queen snake west of the Mississippi River. Reagan (1974) and Smith *et al.* (1984) pointed out the need for a critical assessment of the status of *R. septemvittata* in Arkansas.

The present study was undertaken to identify new populations of *R. septemvittata* in Arkansas and to verify the existence of populations from localities of previous state records. In addition, museum specimens were examined to summarize data on size and scutellation and dissected to reveal their reproductive condition. Information presented, herein, will add to a database on this species in Arkansas.

MATERIALS AND METHODS

Field work was conducted May through September, 1990. Thirty-seven localities in 11 counties were visited (Table 1); five of these were searched more than once. The primary collecting method was turning over large rocks within streams or along their edges (Branson and Baker, 1974). At each site, a distance of from 0.2-0.8 km above and below the entrance point was investigated. Snakes were killed by an intraperitoneal injection of sodium pentobarbitol. The snout-vent length (SVL) and tail length (TL) were measured following fixation in 10% formalin and preservation in 70% ethanol. Testes were removed from three males (includes museum specimens) and prepared for light microscopy using standard histological methods (Humason, 1979). In four females, vitellogenic ovarian follicles, oviductal eggs, and/or developing embryos were counted and measured. All snakes collected during this study were deposited in the Arkansas State Museum of Zoology.

Table 1. Snake survey data from 37 collection sites from major creeks or river systems within the Interior Highlands of Arkansas. Data were gathered during the spring and summer of 1990. Snake species include: *Agkistrodon piscivorus leucostoma* (APL), *Nerodia erythrogaster flavigaster* (NEF), *N. sipedon pleuralis* (NSP), and *Regina septemvittata* (RS). The number of snakes collected is followed by the number observed (in parentheses). Asterisk denotes site of a literature record.

County and General Locality	Township, Range, Section	Snake Species
Crawford		
Mulberry River and Interstate 40	T10N, R29W, Sec 24	2 NSP; 1 RS
Mulberry River and St. Hwy 215	T10N, R29W, Sec 14	2 NSP (4)
Jone's Fork (Frog Bayou)	T12N, R29W, Sec 8	2 NSP
Frog Bayou and NFR 1000)	T12N, R29W, Sec 10	-
Frog Bayou and St. Hwy 282)	T11N, R30W, Sec 21	3 NSP
Lee Creek and U.S. Hwy 59	T11N, R32W, Sec 10	2 NSP
Faulkner		
*Cadron Creek and U.S. Hwy 65	T8N, R13W, Sec 29	-
Batesville Creek and U.S. Hwy 65	T8N, R13W, Sec 8	-
Franklin		
Mountain Creek	T12N, R26W, Sec 19	1 NSP
*Mulberry River and St. Hwy 23	T12N, R27W, Sec 35	1 APL; 2 NSP
Mulberry River	T12N, R27W, Sec 35	-
Hurricane Creek	T11N, R28W, Sec 10	-
Mulberry River and Interstate 40	T10N, R29W, Sec 24	1 NSP; 1 RS
Garland		
*Hot Springs Creek	T3S, R19W (Fontana Rd., Hot Springs)	4 NSP
Hot Spring		
Blakely Creek and St. Hwy 84	T4S, R18W, Sec 35	1 NSP (4)
Independence		
*Salado Creek	T11N, R7W, Sec 2	1 APL; 9 NSP (11)
Salado Creek	T12N, R7W, Sec 35	3 APL
Salado Creek and U.S. Hwy 167	T11N, R6W, Sec 2	-
Johnson		
Big Piney Creek and St. Hwy 123	T12N, R12W, Sec 20	1 NSP
Little Piney Creek and St. Hwy 123	T11N, R22W, Sec 26	-
Horsehead Creek	T11N, R25W, Sec 24	-
Mulberry River	T12N, R23W, Sec 16	-
Mulberry River	T12N, R24W, Sec 21	-
*Mulberry River and Co. Hwy 103	T12N, R25W, Sec 24	2 NEF; 3 NSP (5); 2 RS
Mulberry River	T12N, R24W, Sec 21	1 NSP
Madison		
Kings River and St. Hwy 74	T16N, R24W, Sec 28	1 NSP
Newton		
Buffalo River and St. Hwy 21	T15N, R23W, Sec 15	-
Pope		
Illinois Bayou and St. Hwy 164	T10N, R19W, Sec 21	-
Illinois Bayou	T10N, R19W, Sec 32	-
Illinois Bayou and St. Hwy 27	T10N, R19W, Sec 24	NSP (1)
Illinois Bayou and NFR 1000	T12N, R19W, Sec 21	-
Big Piney Creek and St. Hwy 164	T10N, R21W, Sec 24	3 NSP
Van Buren		
Pee Dee Creek	T11N, R13W, Sec 7	-
Weaver Creek	T12N, R13W, Sec 34	-
South Fork, Little Red River and St. Hwy 95	T11N, R15W, Sec 33	1 NSP
South Fork, Little Red River	T11N, R15W, Sec 30	1 APL (2); 1 NSP

RESULTS AND DISCUSSION

DISTRIBUTION

Four *Regina septemvittata* were collected during the present study from three localities in Crawford and Johnson counties (Fig. 1; sites 2, 3, and 5). No queen snakes were observed at any other locality; this includes the historic sites (1, 4, 6, 7, and 8).

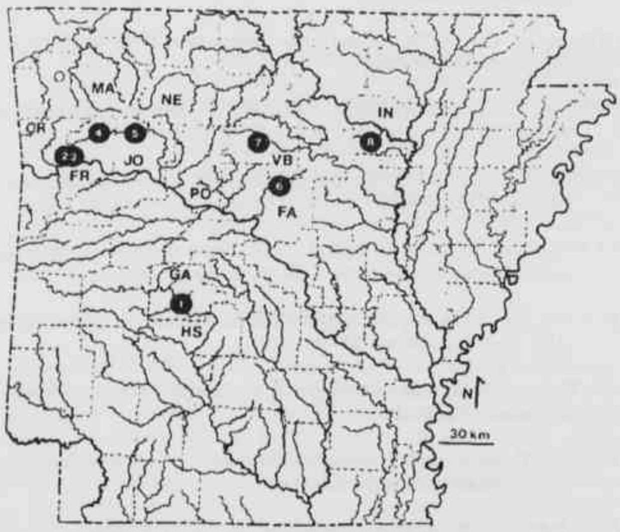

Figure 1. Map of Arkansas showing major drainage systems. Numbered sites representing known localities from voucher specimens or literature records for *Regina septemvittata* are: 1) Hot Springs Creek, 2-5) Mulberry River, 6) Cadron Creek, 7) South Fork, Little Red River, and 8) Salado Creek. Abbreviations for counties are: Crawford (CR), Faulkner (FA), Franklin (FR), Garland (GA), Hot Spring (HS), Independence (IN), Madison (MA), Newton (NE), Pope (PO), and Van Buren (VB). Open circle represents historic site, although no voucher specimen presently exists (Dowling, 1957).

SCUTELLATION AND SIZE

Data on scutellation of Arkansas specimens (n = 7) of *Regina septemvittata* are found in Conant (1960). The following data (mean, range, and no. of specimens) on counts of ventrals and subcaudals by sex (males followed by females) include the specimens analyzed by Conant (1960): ventrals – 152.6, 144-159, 7, 153.4, 151-157, 10; subcaudals – 72.4, 71-74, 5, 67.1, 62-77, 10. These same counts on a single clutch of late-term embryos are: ventrals – 151.2, 147-155, 6, 149.8, 148-152, 4; subcaudals – 73.0, 66-78, 6, 68.0, 57-69, 4. The female of this clutch possessed 152 ventrals and 64 subcaudals. The grand total for all specimens (± 2 SE) are: ventrals – 152.1±1.2, 144-159, 27; subcaudals – 69.7±2.1, 57-78, 25. The mean values for the number of ventrals was greater than values found for *R. septemvittata* in Ohio (Wood and Duellman, 1950), whereas the mean number of subcaudals in the Arkansas specimens was approximately equal to those in Ohio.

The largest Arkansas specimen was a female measuring 528 mm SVL (total length, 658 mm) of seven adults examined; the largest male measured 443 mm SVL (tail broken). As pointed out by Wood and Duellman (1950), females are always the longest specimens regardless as to what part of the range specimens are collected. Newly-born young of *Regina septemvittata* range from 166-225 mm in total length (Wood and Duellman, *op. cit.*). One juvenile, collected 16 September 1972, measured 198 mm SVL and 63 mm TL. A gravid female, collected 23 July 1987, contained embryos (n = 10) that averaged 106.1 mm SVL (range, 103-109) and 35.5 mm TL (33-38).

REPRODUCTION

Clutch and/or litter size in *Regina septemvittata* was summarized by Fitch (1985); northern populations in the eastern United States averaged 16.4 (4-39), whereas southern populations averaged 12.2 (6-19). Clutch size in two Arkansas females (SVL = 380 and 440 mm) exhibiting small yolked ovarian follicles (mean length, 3.5 and 4.4 mm) was 14 and 19, respectively. In two gravid females (SVL = 469 and 528 mm), clutch size was 7 and 10, respectively. Based upon the size of the embryos of the above gravid females, it appears that queen snakes give birth in August or early September. Queen snakes are known to mate in the spring and/or the fall (Branson and Baker, 1974). A histological examination of the left testis of an adult male (SVL = 403 mm) collected 20 July 1990 revealed sperm within the seminiferous tubules (Fig. 2).

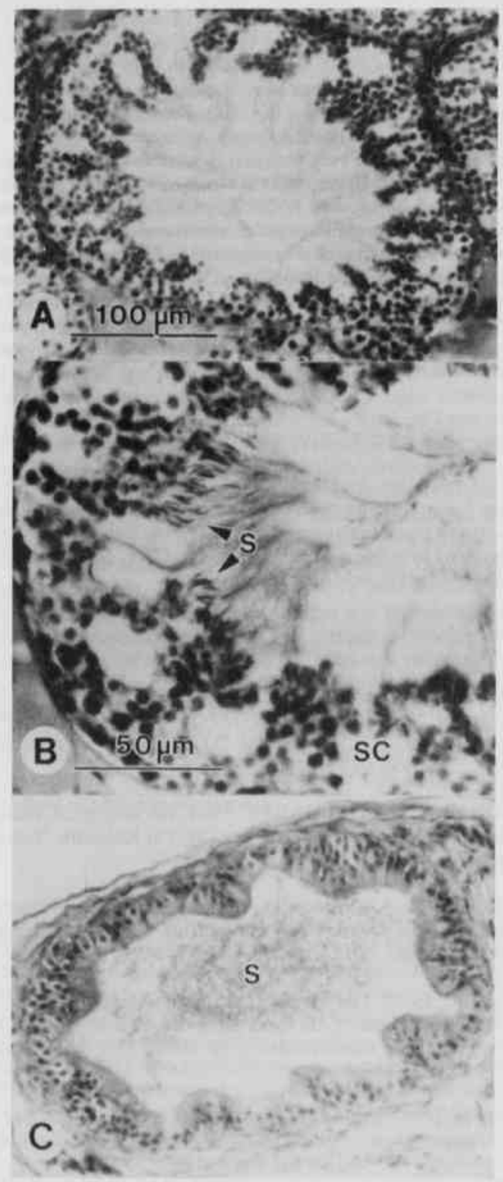

Figure 2. Photomicrographs of seminiferous and epididymal tubules of *Regina septemvittata*. A. Seminiferous tubule in the process of spermiation. B. Magnification of a seminiferous tubule showing the release of sperm (S). C. Epididymal tubule with sperm (S). Magnification the same as in A.

Ernst and Barbour (1989) pointed out that queen snakes prefer clean, unpolluted streams in the eastern United States. They also stated that water pollution and possibly acid rain have reduced crayfish populations in many parts of the range of queen snakes and have eliminated the snake from these areas. During the present study, water pollution was obvious, especially in the Mulberry River. Enrichment of flowing water from cattle pastures, poultry operations, and human occupation along the Mulberry as well as other rivers may be the greatest threat to the survival of queen snakes within the snake's optimal habitats in the Boston Mountains. The present study was unable to establish the existence of any large aggregates or populations of queen snakes, possibly because most of the sites investigated showed heavy use by man. All streams within the Boston Mountains become flowing torrents after heavy spring rains; this is especially common in early spring at the time when queen snakes have not left their hibernation dens. These rain showers may, in effect, temporarily cleanse terrestrial habitats of their sources of enrichment prior to emergence by snakes. By mid-to-late summer, these watersheds receive reduced amounts of rain and become sluggish with respect to the movement of nutrients. Algal blooms were common in several streams during late summer; however, the effect of polluted watersheds on the life history of *R. septemvittata* in Arkansas remains unknown.

Queen snakes may be very common in suitable habitats with abundant crayfish (Branson and Baker, 1974); Wood (1949) collected 125 specimens within 92 m in a stream in Ohio. The rarity of queen snakes in the presence of abundant crayfish populations (as was the case in the present study) may be suggestive of a species nearing extirpation from causes other than diminished food resources. The biology of *R. septemvittata* will require further study before its status can be adequately determined in Arkansas; yet, based upon the present findings (or lack thereof), this species qualifies as a rare species and deserves formal recognition as being threatened or endangered.

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